

Status of the Cryogenic Dark Matter Search



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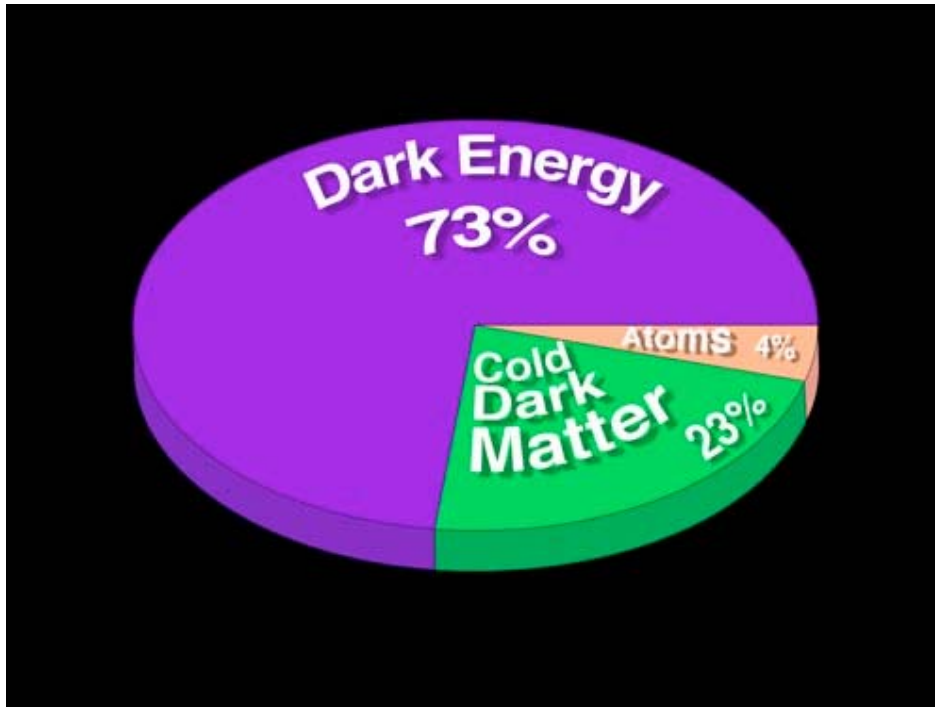
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NIST, U Colorado Denver, Brown U, U Minnesota



The Universe, according to WMAP



What is the cold dark matter?

Convergence of cosmology

“cold” dark matter: density $\sim 1/\text{interaction rate}$
 \Rightarrow weak-scale cross sections

and particle physics

Supersymmetry provides massive neutralino
 \Rightarrow weak-scale cross sections

Weakly Interacting Massive Particles (WIMPs) may be dominant matter in the universe \Rightarrow

WIMP wind from galactic dark matter halo

Is there a way to detect this directly?

What is CDMS?

Dark Matter Search

Goal is direct detection of WIMPs which appear to hold our galaxy together

Cryogenic

Cool very pure Ge and Si crystals to < 50 mK using dilution refrigerator

Active Background Rejection

Detect heat and charge

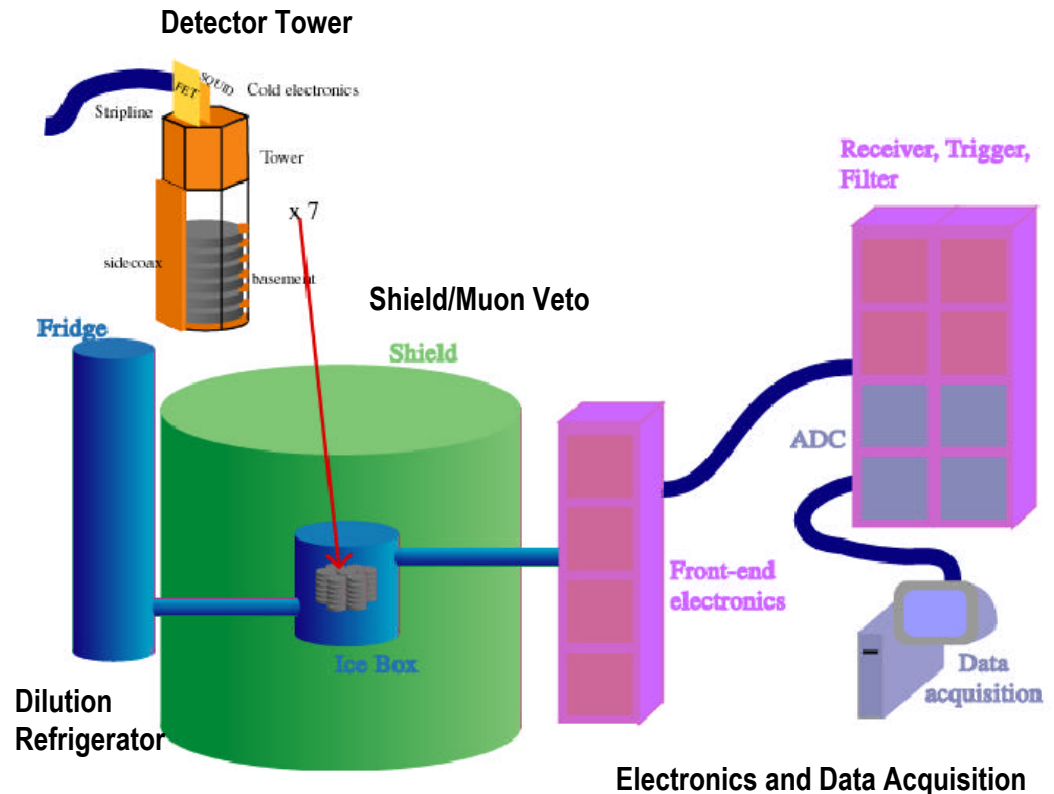
WIMPS, neutrons \Rightarrow nuclear recoils

Charge/Heat $\sim 1/3$

EM backgrounds \Rightarrow electron recoils

Charge/Heat = 1

Reject neutrons using multiple scattering and comparison of Ge to Si rates



Shielding

Layered shielding against radioactive backgrounds and active cosmic ray scintillator veto ($>99.9\%$ efficient).

CDMS at Stanford

Shielded, low-background environment

Shallow (17 mwe) site

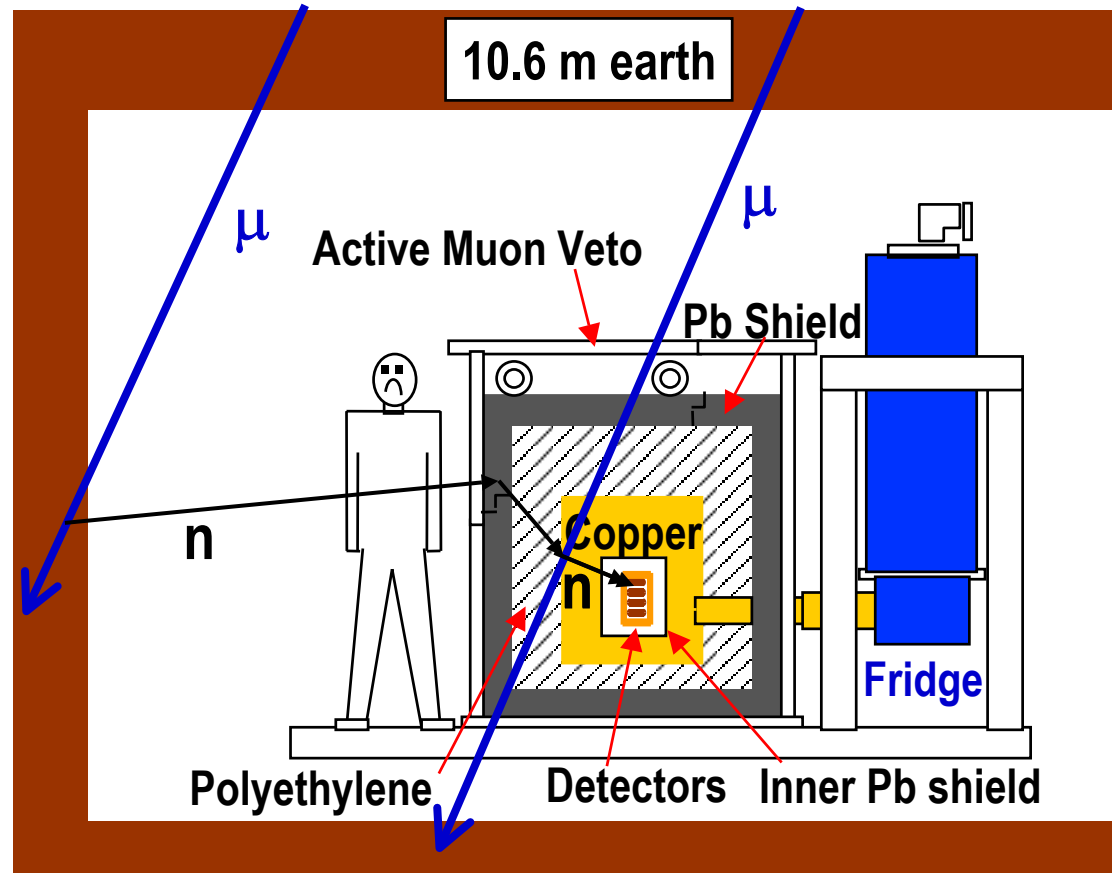
Hadronic cosmic-ray flux
reduced by $>1000\times$

Muons reduced by $\sim 5\times$

Active muon veto

$>99.9\%$ efficient

Reject ~ 100 neutrons per
kg-day produced by
muons within shield



**Expect neutron background ~ 2 / kg / day produced outside shield;
measure using**

Si slightly more sensitive to neutrons, Ge $\times 5$ more sensitive to WIMPs

Multiple-detector scatters must be neutrons, not WIMPs

ZIP Detectors

Z-sensitive Ionization and Phonon Detectors

Low-voltage ionization measurement

Athermal phonon measurement

low-noise **SQUID** readout

Measured background rejection:

> 99.9% for EM backgrounds using charge/heat

> 98% for β 's using pulse risetime as well

Better than expected in CDMS II proposal!



Tower of 6 ZIPs

Tower 1

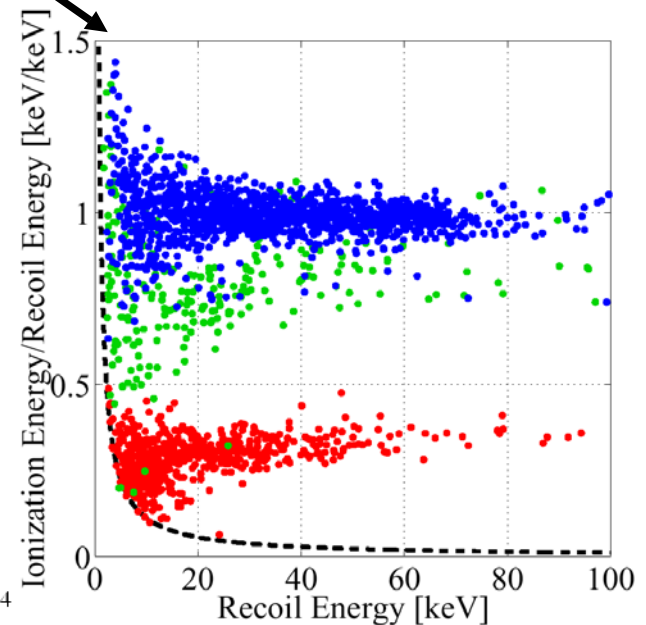
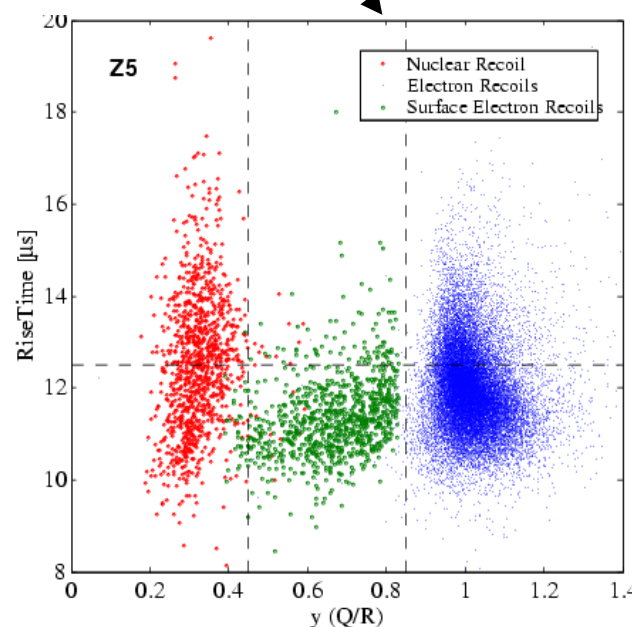
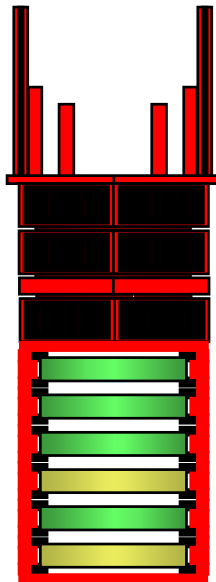
4 Ge

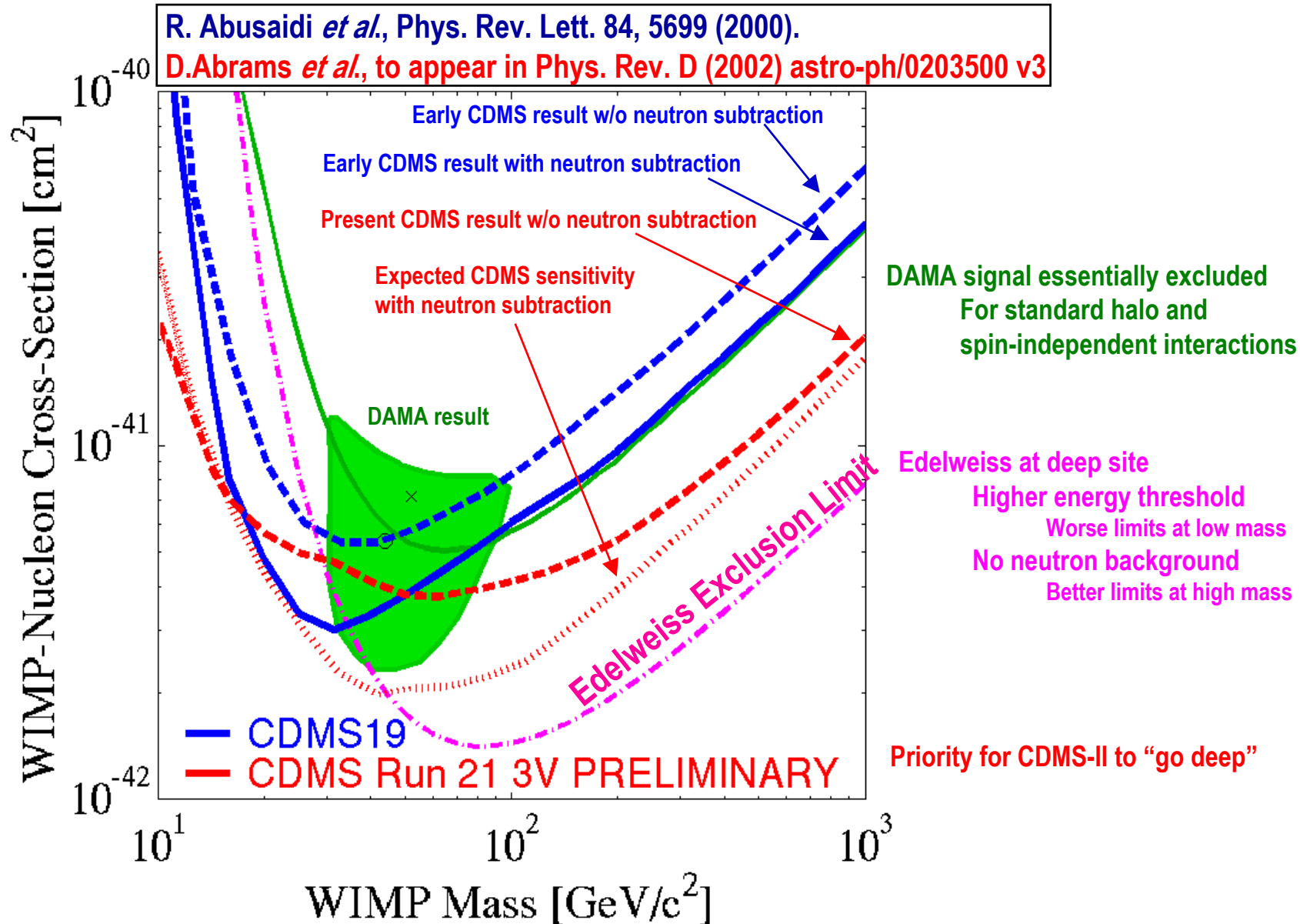
2 Si

Tower 2

2 Ge

4 Si

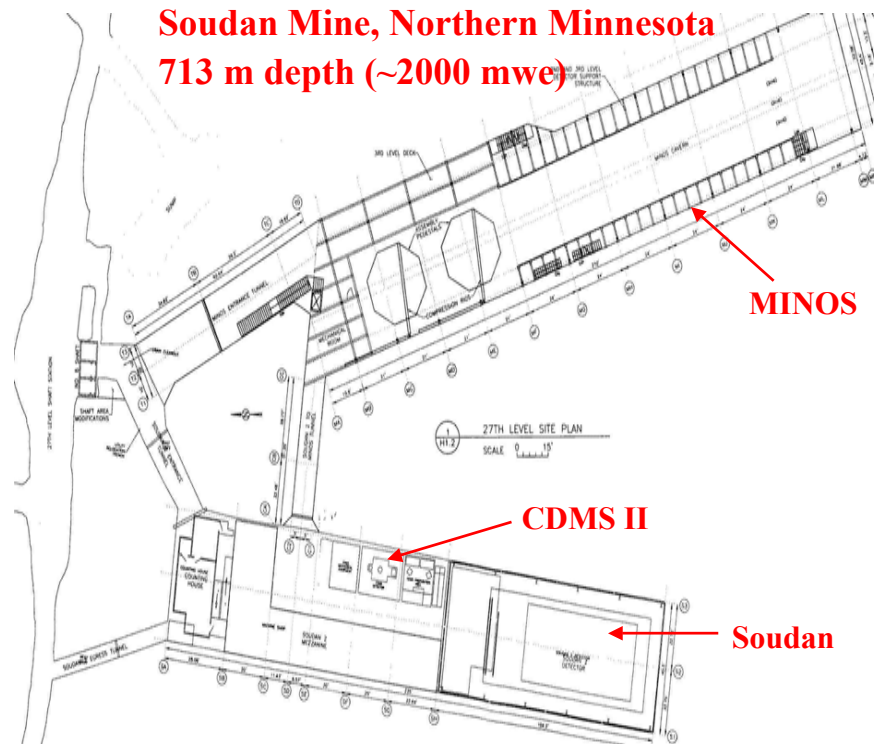
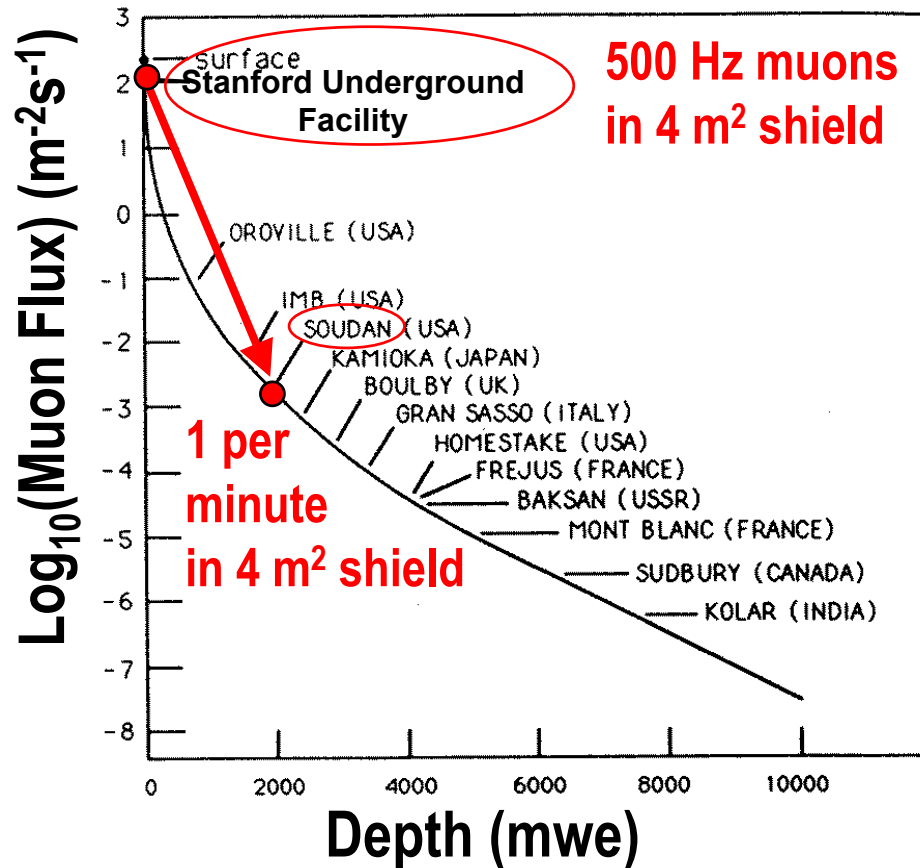




CDMS II at Soudan

Depth of 2000 mwe reduces neutron background from
 $\sim 1 / \text{kg} / \text{day}$ to $\sim 1 / \text{kg} / \text{year}$

Expect WIMP sensitivity of $0.01 / \text{kg} / \text{kev} / \text{day}$



CDMS II Cryogenics at Soudan

Serious problems with dilution refrigerator => 1 year delay

Problems now resolved (intense effort within collaboration)

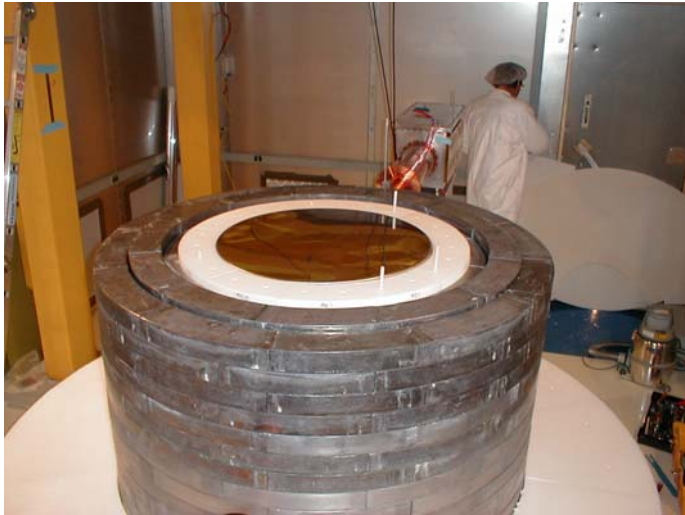
Dilution refrigerator and icebox (detector cold volume) coupled

Cooled to 25 mK for 1 week in December, 2002



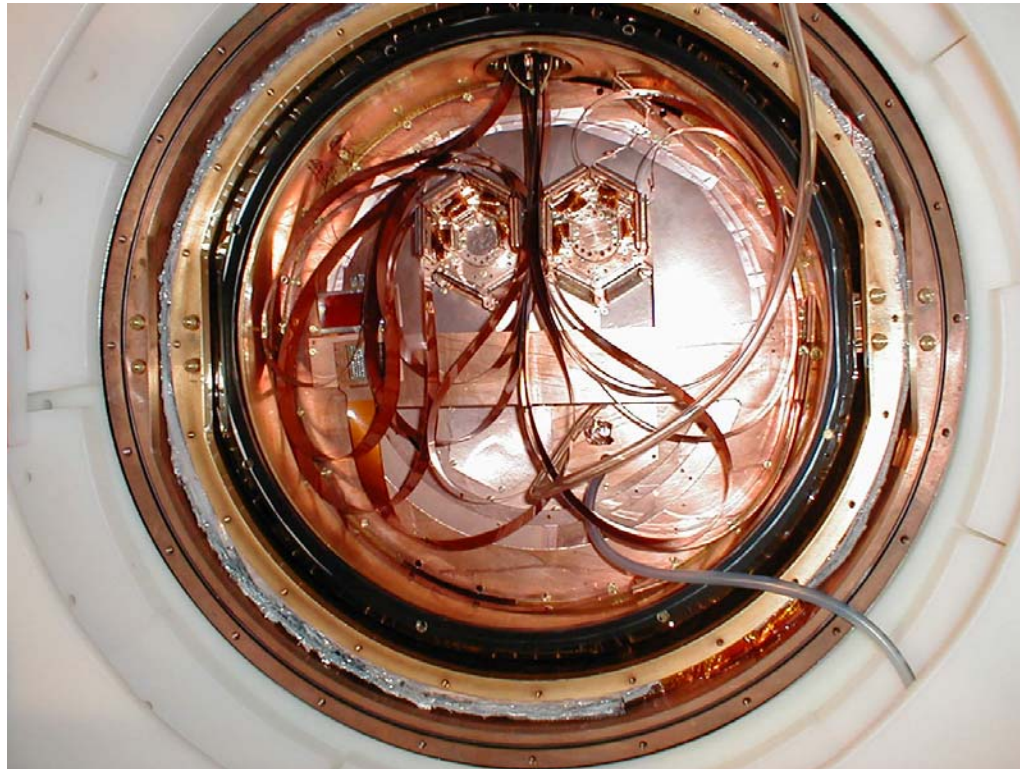
CDMS II Installation at Soudan

Shielding, DAQ, and Electronics nearly finished
System testing underway

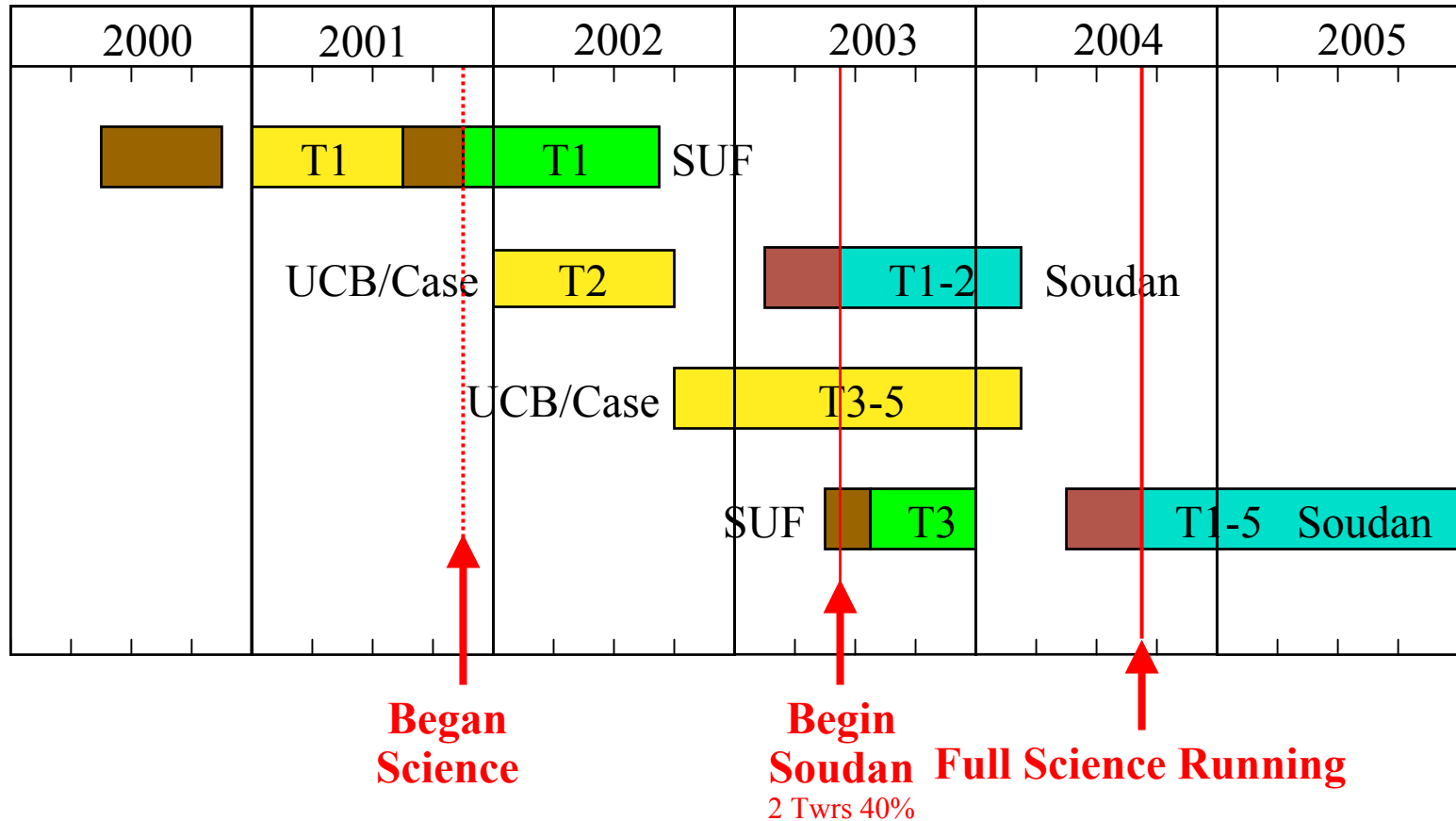


Detector Installation at Soudan

Two towers of Ge/Si detectors just installed
Warm checkout for next two weeks; then cooldown
First “dark” in April, 2003; commissioning/calibration
First “low-background” data in June, 2003

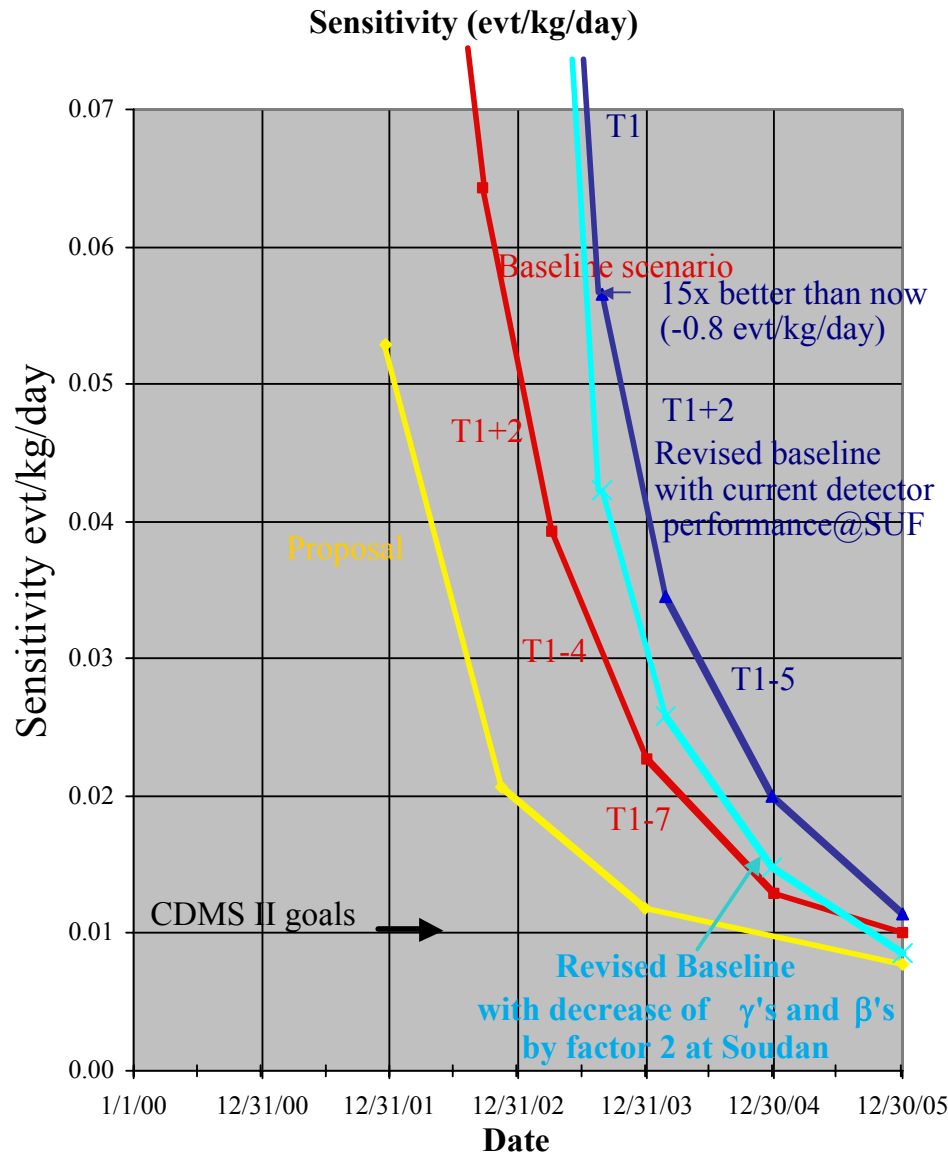


CDMS-II Schedule



This plan achieves science goals for original proposal. We plan to submit proposal to complete Towers 6-8 as follow-on with improved science reach.

CDMS II Expected Sensitivity



1 year delay: cryogenic problems

Dilution refrigerator, icebox now working

Experiment nearly ready at Soudan

System testing underway.

First detector deployment in Feb 2003

Tower 1: 4 Ge, 2 Si; Tower 2: 2 Ge, 4 Si

Ge more sensitive to WIMPs; Si needed to determine if signal due to neutrons.

Deep site => Much lower neutron background => Rapid improvement in sensitivity

Expect factor of 10 improvement over CDMS I results by end of 2003.

Deploy remainder of detectors in 2004 and run until end of 2005 (or longer)

Detector performance improvements mean we should still reach original CDMS II goals (cyan curve)

CDMS II Reach

New CDMS result from
Stanford site (thin blue curve)
Best WIMP limits at
low mass

CDMS II should begin taking
data by Summer 2003
Expect x10 improvement
in limits by end of 2003
(or maybe hint of a signal?)

No other running experiment
will make such rapid progress
Power of active background
rejection.

